High p_T Azimuthal Asymmetry in noncentral A+A at RHIC *

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A new way to probe parton energy loss ΔE in variable geometries was recently proposed by Wang. The idea is to exploit the spatial azimuthal asymmetry of non-central nuclear collisions. The dependence of ΔE on the path length $L(\phi)$ naturally results in a pattern of azimuthal asymmetry of high p_{T} hadrons which can be measured via the differential elliptic flow parameter (second Fourier coefficient), $v_2(p_{\mathrm{T}})$. In this letter, we predict $v_2(p_{\mathrm{T}} > 2$ GeV) for two models of initial conditions which differ by an order of magnitude. We first generalize the finite energy GLV theory to take into account the expansion (neglected in) of the produced gluon-dominated plasma while retaining kinematic constraints important for intermediate jet energies. Another novel element of the analysis is a discussion of the interplay between the azimuthally asymmetric soft (hydrodynamic) and hard (quenched jet) components of the final hadron distributions. We show that the combined pattern of jet quenching in the single inclusive spectra and the differential elliptic flow at high p_{T} provide complementary tools that can determine the density as well as the spatial distribution of the quark-gluon plasma created at RHIC.

In nuclear collisions jet quenching can modify the hard cross section by changing the kinematic variables of the effective fragmentation function. We include this effect by replacing the vacuum fragmentation function in the differential cross section by an effective quenched one.

The dominant (generalized) first order radiation *intensity* energy loss that holds also for expanding plasmas is given by $(z = \tau)$

$$\Delta E \approx \frac{C_R \alpha_s}{2} \int_{z_0}^{\infty} dz \, \frac{\mu^2(z)}{\lambda(z)} \, (z - z_0) \log \frac{E}{\mu(z)} \, , \qquad (1)$$

With Bjorken approximations, the total energy loss is proportional to the line integral along the jet trajectory $\mathbf{r}(z,\phi) = \mathbf{r} + \hat{v}(\phi)(z - z_0)$, averaged over the distribution of the jet production points

$$F(\mathbf{b},\phi) \;=\; \int d^2\mathbf{r} \, \frac{T_A(\mathbf{r}) T_B(\mathbf{r}-\mathbf{b})}{T_{AB}(\mathbf{b})} \int_{z_0}^{\infty} dz \, z \left(\frac{z_0}{z}\right)^{\alpha} T_A(\mathbf{r}(z,\phi)) T_B(\mathbf{r}(z,\phi) - \mathbf{b}) \, , \qquad (2)$$

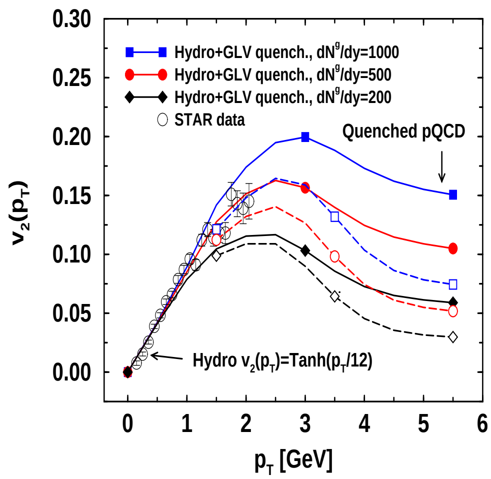

Figure 1: The interpolation of $v_2(p_{\mathrm{T}})$ between the soft hydrodynamic [**?**] and hard pQCD regimes is shown for $b = 7$ fm. Solid (dashed) curves correspond to cylindrical (Wood-Saxon) geometries.

For a non-vanishing impact parameter $\mathbf{b}$ and jet direction $\hat{v}(\phi)$, we calculate the energy loss as

$$\frac{\Delta E\,(\mathbf{b},\phi)}{E} = \frac{F\,(\mathbf{b},\phi)}{F\,(\mathbf{0},\phi)} \, \frac{\Delta E\,(0)}{E} \equiv R(\mathbf{b},\phi) \, \frac{\Delta E\,(0)}{E} \, , \quad (3)$$

where the modulation function $R(\mathbf{b},\phi)$ captures in the *linearized* approximation the $\mathbf{b}$ and ϕ dependence of the jet energy loss.

The figure shows the predicted pattern of high p_{T} anisotropy. We conclude that $v_2(p_{\mathrm{T}} > 2\,\mathrm{GeV}, \mathbf{b})$ provides essential complementary information about the geometry and impact parameter dependence of the initial conditions in $A+A$. In particular, the rate at which the v_2 coefficient decreases at high p_{T} is an indicator of the diffuseness of that geometry.

*Phys.Rev.Lett. **86**, 2537 (2001)